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WAR DEPARTMENT

FIELD ARTILLERY FIELD MANUAL

SERVICE OF THE PIECE

105-MM HOWITZER, M2, TRUCK-DRAWN

December 12, 1941

FM 6–75

FIELD ARTILLERY FIELD MANUAL

SERVICE OF THE PIECE

105-MM HOWITZER, M2, TRUCK-DRAWN

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Chief of Field Artillery

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(For explanation of symbols see FM 21–6.)

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FIELD ARTILLERY FIELD MANUAL

SERVICE OF THE PIECE

105-MM HOWITZER, M2, TRUCK-DRAWN

SECTION I

GENERAL

■ 1. PURPOSE AND SCOPE.—This manual prescribes the duties to be performed in the service of the piece by the personnel normally assigned to one howitzer section of the firing battery.

■ 2. REFERENCES.—*a. Description, operation, functioning, and care of matériel.*—TM 9–325; SNL C–21.

b. Description and operation of fire-control and sighting equipment.—TM 9–325; SNL F–1.

c. Ammunition.—TM 9–325; TM 9–1900; SNL R–1.

d. Cleaning and preserving materials.—TM 9–850; SNL K–1.

e. Automotive driver.—FM 25–10.

f. Maneuvers of battery.—Part Two, FM 6–5.

g. Safety precautions in firing.—AR 750–10; FM 6–40.

h. Firing battery.—FM 6–40.

i. Gunnery.—FM 6–40.

j. Reconnaissance, occupation, and organization of position.—FM 6–20.

■ 3. DEFINITIONS AND TERMS.—*a. Section.*—Tables of Organization prescribe the personnel and matériel comprising a section of a battery. In this manual the term is frequently used to designate a section of the firing battery. In this restricted sense, a howitzer section is composed of one piece and the additional matériel and the personnel required to serve that piece.

b. Coupled.—A piece is said to be coupled when its lunette is attached to the pintle of a truck or other prime mover.

c. Uncoupled.—A piece is said to be uncoupled when its lunette is detached from the pintle of a truck or other prime mover and the trail rests on the ground.

d. Front.—The front in a section, carriages coupled, is the direction in which the trail points; carriages uncoupled, the direction in which the muzzle of the piece points.

e. Right (left).—The direction right (left) is the right (left) of one facing the front.

f. In battery.—A howitzer is said to be in battery when it is in its normal firing position.

SECTION II

ORGANIZATION

■ 4. COMPOSITION.—*a. Howitzer squad.*—A howitzer squad consists of the gunner and seven cannoneers numbered from 1 to 7.

b. Howitzer section.—A howitzer section consists of a chief of section, a howitzer squad, a driver, and additional cannoneers and an assistant driver who may be assigned or attached. The additional cannoneers act as reliefs or are assigned to other duties as the chief of section may direct. When the section uncouples for drill or for firing, the chief of section remains at the position of the piece and commands the howitzer squad.

c. Ammunition squad.—(1) An ammunition squad consists of an ammunition corporal and cannoneers as prescribed in Tables of Organization. These cannoneers are numbered consecutively, beginning with No. 1, and are assigned to the ammunition vehicles of the ammunition (fifth) section.

(2) Posts and movements prescribed hereinafter for the howitzer squad apply with obvious modifications to an ammunition squad.

d. Ammunition section.—The ammunition section consists of the chief of section, the ammunition squad, and the drivers of the ammunition trucks of the ammunition (fifth) section.

■ 5. FORMATION.—*a. Order of formation.*—A howitzer squad is formed as shown in figure 1. Higher-numbered cannoneers, if present, form in order on the left of No. 7.

b. To form.—(1) The place of formation is indicated and the command given thus, for example: 1. IN FRONT (REAR) OF YOUR PIECES, or 1. ON THE ROAD FACING THE PARK, 2. FALL IN. Each gunner repeats the command FALL IN and hastens to place himself, faced in the proper direction, at the point where the right of his squad is to rest. The cannoneers move at the double time and assemble at attention in their proper places. For the first formation of the howitzer

squads for any drill or exercise, the caution, "As howitzer squads," precedes the command. The chief of section, if present, supervises the formation.

(2) In case the front or rear of the carriages is designated, each squad falls in at its post (par. 6).

c. To call off.—(1) The command is: CALL OFF. The cannoneer on the left of the gunner calls off "One"; the cannoneer on the left of No. 1, "Two"; and so on.

(2) After having called off, if a subsequent formation is ordered, the cannoneers fall in at once in their proper order.

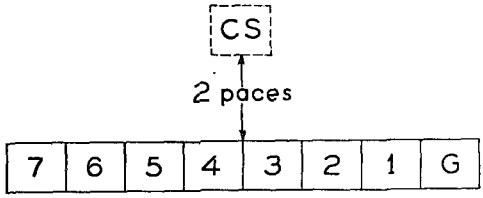


FIGURE 1.—Formation of howitzer squad.

SECTION III

POSTS: MOUNTING AND DISMOUNTING

■ 6. POSTS OF HOWITZER SQUADS.—*a. Carriages coupled.*—(1) *In front of piece.*—The squad is in line facing to the front, its center 2 paces from the front of the truck.

(2) *In rear of piece.*—The squad is in line facing to the front, its center 2 paces from the muzzle of the piece.

b. Carriages uncoupled.—In rear of piece.—The squad is in line facing to the front, its center 2 paces from the end of the trail.

■ 7. TO POST HOWITZER SQUADS.—The squads having been marched to the vicinity of the carriages are posted at the command SQUADS IN FRONT (REAR) OF YOUR PIECES. Each gunner marches his squad to its carriage and posts it in the position indicated.

■ 8. POSTS OF CANNONEERS.—*a. Carriages coupled.*—The cannoneers of the howitzer squad are posted as shown in figure 2. All are 2 feet outside the wheels and facing to the front.

Higher-numbered cannoneers, if present, are posted as prescribed by the chief of section.

b. Carriages uncoupled.—See paragraph 17 and figure 5.

■ 9. To POST CANNONEERS.—*a.* The command is: 1. CANNONEERS, 2. POSTS. Each gunner repeats the command POSTS. The cannoneers move at the double time to their posts.

b. For preliminary instruction, the squads on entering the park are first posted with their carriages, and cannoneers are then sent to their posts by the foregoing command. The command is general, however, and is applicable when the cannoneers are in or out of ranks, at a halt or marching, and when the carriages are coupled or uncoupled.

■ 10. To MOUNT.—*a.* The command is: 1. CANNONEERS, PREPARE TO MOUNT, 2. MOUNT. At the first command, the cannoneers move at the double time to positions shown in figure 3. At the second command, the cannoneers of both columns mount in the order from head to rear, and take seats as shown in figure 4. Each cannoneer is assisted by the one directly behind (or in front in the case of the last cannoneer in column) to insure promptness and prevention of injuries. If the chief of section and driver are to be included in the movement, the command is: 1. PREPARE TO MOUNT, 2. MOUNT. At the first command, the chief of section takes position 2 feet from the right side of the truck and opposite his seat; the driver takes position 2 feet from the left side of the truck and opposite his seat; each opens his door and faces to the front holding the door open. At the second command, they mount, take seats, and close their doors.

b. If the command is: 1. CANNONEERS, 2. MOUNT, the cannoneers execute, at the command MOUNT, all that has been prescribed for the commands CANNONEERS, PREPARE TO MOUNT and MOUNT. If the chief of section and driver are to be included in this movement, the command is: MOUNT.

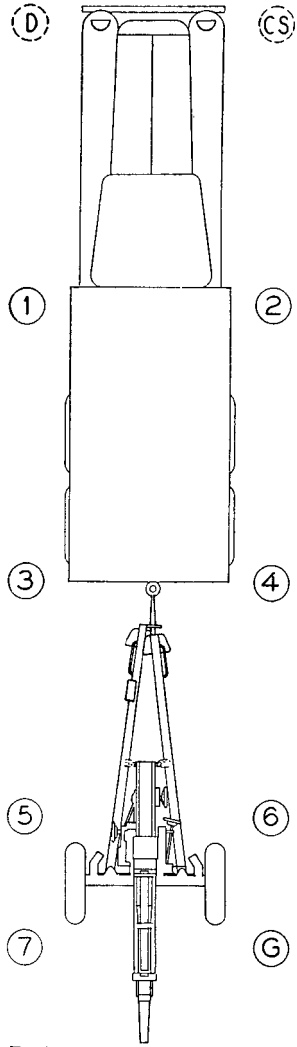


FIGURE 2.—Posts of cannoneers, howitzer coupled.

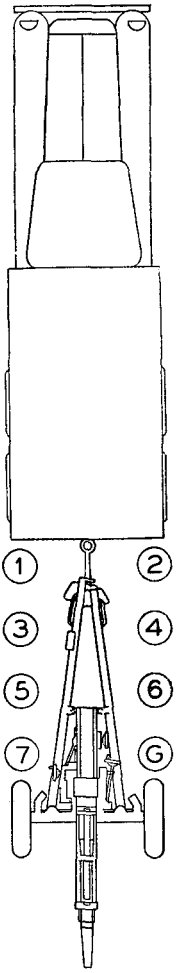


FIGURE 3.—Posts of cannoneers in PREPARE TO MOUNT.

■ 11. To DISMOUNT.—*a.* The command is: 1. CANNONEERS, PREPARE TO DISMOUNT, 2. DISMOUNT. At the first command, the cannoneers assume standing positions facing the rear of the truck; at the second command, they jump to the

ground and, at the double time, take posts as shown in figure 2. If the chief of section and driver are to be included in this movement, the command is: 1. PREPARE TO DISMOUNT, 2. DISMOUNT. At the first command, the chief of section and driver unlatch their doors and hold them slightly open; at the second command, they promptly dismount, close their doors, and take posts as shown in figure 2.

b. If the command is: 1. CANNONEERS, 2. DISMOUNT, the cannoneers execute, at the command DISMOUNT, all that has been prescribed for the commands CANNONEERS PREPARE TO DISMOUNT and DISMOUNT. If the chief of section and driver are to be included in this movement, the command is: DISMOUNT.

SECTION IV

MOVEMENTS OF THE CARRIAGES BY HAND

■ 12. COUPLED.—The carriages are not moved by hand when coupled.

■ 13. UNCOUPLED.—*a.* The command is: 1. PIECES FORWARD (BACKWARD), 2. MARCH. At the first command, the gunner and No. 1 remove the trail lock pins and place them in the traveling positions. Nos. 2 and 6 on the left trail and 3 and 7 on the right trail manipulate the trails as directed by No. 4 so that the axle locks may be locked by Nos. 4 and 5, working on the left and right, respectively. Nos. 2, 3, 6, and 7 close the trails, and No. 6, assisted by No. 7, fastens the trail lock. The gunner and No. 1 release the hand brakes. Nos. 2 and 6 and Nos. 3 and 7 then grasp the trail handles on the left and right, respectively. No. 4 grasps the left wheel, No. 5 the right wheel. The gunner and No. 1 place themselves advantageously at the breech of the piece in moving forward; at the muzzle in moving backward. Higher-numbered cannoneers, if present, are employed as directed by the chief of section. If the situation requires the use of prolonges, Nos. 4 and 5, under the direction of the chief of section, will obtain the prolonges and attach them to the hooks on the left and right axles, respectively. Personnel designated by the battery executive to assist in the movement of the piece will take position and pull on the prolonges as directed by the chief of section.

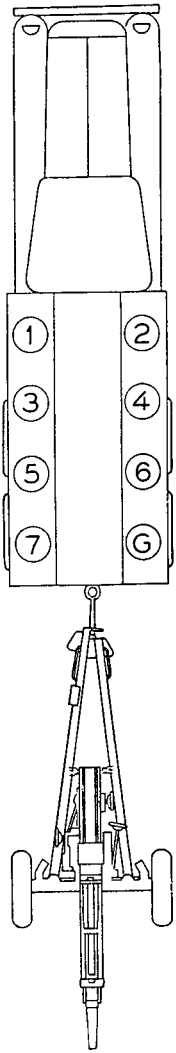


FIGURE 4.—Posts of cannoneers mounted.

b. At the command MARCH, all move the piece forward (backward) under the direction of the chief of section. When the piece is being moved up or down steep slopes, the gunner and No. 1 assist by alternately setting and releasing the left and right brakes, thus permitting the piece to be pivoted about the alternately locked wheels. At the command HALT, the piece is stopped and reestablished in the firing position; all resume their posts (par. 17).

SECTION V

UNCOUPLING AND COUPLING

■ 14. UNCOUPLING.—*a. General.*—At drills, trucks are posted as directed by the battery commander. In active service and in instruction simulating it, the trucks are conducted by the first sergeant to a place previously designated by the battery commander; there they are disposed so as to take the best advantage of cover and concealment. If no cover and concealment are available, the trucks are located in rear of either flank, faced to the front, with wide intervals between them.

b. To fire to front.—The command is: ACTION FRONT. If marching, the trucks halt at the command or signal. The cannoneers, if mounted, dismount after the trucks have halted.

(1) *Pieces.*—The gunner and No. 1 hasten to the wheels nearest their respective posts. Nos. 2, 3, 6, and 7 hasten to the trail handles, even numbered cannoneers on the right, odd numbers on the left. Nos. 4 and 5 go to the muzzle of the piece, and assist by placing their weight on the tube. No. 3 disengages the electric brake cable and safety chain from the prime mover. No. 2 unlatches the pintle and, assisted by Nos. 3, 6, and 7, raises the trail from the pintle; the gunner sets the left wheel brake. Nos. 2, 3, 4, 5, 6, and 7 swing the piece 180° clockwise. No. 3 releases the drawbar lock and turns the drawbar 180°, latching it in the firing position. Nos. 2, 3, 6, and 7 then lower the trail to the ground. No. 1 sets the right wheel brake. The gunner and all cannoneers then unload the ammunition, tools, and accessories and arrange them in an orderly and convenient manner to the left of the piece. When the unloading has been completed, the chief of section commands or signals DRIVE ON. The gunner and cannoneers take their posts (par. 17).

(2) *Trucks.*—At the command DRIVE ON, the trucks move out and are conducted by the first sergeant to their previously designated position.

c. To fire to rear.—The command is: ACTION REAR. The movement is executed according to the principles of ACTION FRONT. The piece is not turned after uncoupling.

d. To fire to flank.—The command is: ACTION RIGHT (LEFT). The movement is executed according to the principles of ACTION FRONT, with the following modifications: After the piece is uncoupled, the trail is turned 90° away from the direction of fire, and the piece is run forward sufficiently to clear the track made by the truck; articles unloaded from the truck are placed on the ground so as to clear the track made by the truck.

■ 15. COUPLING.—*a.* The pieces being in position and in march order, the command is: COUPLE. The trucks, under the command of the first sergeant, approach the position from the right (left) flank. As each truck approaches its piece, it turns to the left (right) and halts in prolongation of the trail of the piece.

b. All cannoneers working together under the direction of the chief of section load the tools, accessories, and unexpended ammunition. Nos. 2, 3, 6, and 7 hasten to the trail handles, even-numbered cannoneers on the left, odd-numbered on the right. Nos. 4 and 5 hasten to the muzzle of the piece. The gunner and No. 1 release the brakes. The truck, upon signal from the chief of section, is maneuvered backward until the pintle is almost over the lunette. Nos. 2, 3, 6, and 7 then raise the trail and, after No. 3 has placed the drawbar in traveling position, place the lunette over the pintle, No. 2 latching the pintle. Nos. 4 and 5 assist by placing their weight on the tube. No. 3 engages the electric brake cable and safety chain to the prime mover. The chief of section verifies that the brakes are operating properly. All cannoneers take their posts.

SECTION VI

PREPARE FOR ACTION AND MARCH ORDER

■ 16. TO PREPARE FOR ACTION.—*a.* The piece being in position uncoupled, the command is: PREPARE FOR ACTION. Duties of individuals are as follows:

(1) *Chief of section.*—(*a*) Supervises the work of the cannoneers.

(*b*) Inspects the matériel; verifies the fact that the recoil mechanism contains the proper amount of oil and that all is in order; and, when the operations have been completed, reports to the executive, "Sir, No. (so-and-so) in order," or reports any defects that the section cannot remedy without delay.

(2) *Gunner.*—(*a*) Assisted by No. 1, removes the breech end of the howitzer cover.

(*b*) Releases the left hand brake momentarily while trails are being spread, to permit action of the equalizer axle.

(*c*) Places the left trail lock pin in the firing position.

(*d*) Removes the panoramic telescope from its case, and seats it in the telescope mount.

(*e*) Uncovers the telescope mount bubbles; sets the index of the rotating head at zero, the deflection at zero, and levels both bubbles.

(*f*) Takes his post.

(3) *No. 1.*—(*a*) Releases the traveling lock.

(*b*) Assists the gunner in removing the breech end of the howitzer cover, throwing the cover to the right of the right wheel.

(*c*) Releases the right hand brake momentarily while trails are being spread, to permit action of the equalizer axle.

(*d*) Places the right trail lockpin in the firing position.

(*e*) Operates elevation handwheel to assist No. 4 in unlocking cradle lock.

(*f*) Uncovers the range quadrant bubbles; if directed by the executive, replaces the range drum for Charge V with the designated drum; sets site 300 and range 3,000, and levels the bubbles.

(*g*) Operates the breech mechanism, and examines the breechblock, chamber, and bore, cleaning any parts requiring it; leaves the breech open.

(*h*) When so directed by the executive, removes the elbow telescope from its case and seats it in its mount.

(*i*) Takes his post.

(4) *No. 2.*—(*a*) Spreads the left trail, assisted by No. 6, when No. 4 calls "Spread."

(*b*) Removes the rammer staff from its traveling position, assembles it to the rammer (bore brush), and places it to the right of the piece.

(*c*) When so directed, assists No. 1 in cleaning the breech mechanism, chamber, and bore of the howitzer.

(*d*) Folds the muzzle and breech ends of the howitzer cover, and places them on the ground to the right of the right wheel of the howitzer.

(*e*) Takes his post.

(5) *No. 3.*—(*a*) Unlocks the drawbar lock, and turns and locks the drawbar in firing position.

(*b*) Spreads the right trail, assisted by No. 7, when No. 4 calls "Spread."

(*c*) Arranges the ammunition and tools, assisted by Nos. 4, 5, 6, and 7.

(*d*) Obtains the fuze setter from the section chest, and places it convenient to the position of the ammunition.

(*e*) Takes his post.

(6) *No. 4.*—(*a*) Unlocks the left axle lock from the traveling position and latches it in the firing position; when he sees that both axle locks are unlocked, calls "Spread," to inform Nos. 2 and 3 that trails may be spread.

(*b*) Unlocks the cradle lock, assisted by No. 1 operating the elevation handwheel, and latches it in firing position.

(*c*) Removes the muzzle end of the howitzer cover, assisted by No. 5.

(*d*) When so directed, lowers left top shield, and locks it in the lowered position.

(*e*) Assists No. 3 in arranging the ammunition and tools.

(*f*) Takes his post.

(7) *No. 5.*—(*a*) Unlocks the right axle lock from the traveling position and latches it in the firing position.

(*b*) Assists No. 4 to remove the muzzle end of the howitzer cover, and throws it on the ground to the right of the right wheel.

(*c*) Removes the aiming posts from the traveling position and places them beside the rammer staff.

(*d*) Assists No. 3 in arranging the ammunition and tools.

(*e*) Takes his post.

(8) *No. 6.*—(*a*) Unlocks the trail lock.

(*b*) Removes the trail handspike from its traveling position and places it in its socket on the left trail.

(*c*) Assists No. 2 in spreading the left trail.

(*d*) Places the section chest, assisted by No. 7, immediately to the left of the piece.

(*e*) Assists No. 3 in arranging the ammunition and tools.

(*f*) Distributes waste to the cannoneers.

(*g*) Takes his post.

(9) *No. 7.*—(*a*) Assists No. 3 to spread the right trail.

(*b*) Assists No. 6 to place the section chest to the left of the piece.

(*c*) Assists No. 3 in arranging the ammunition and tools.

(*d*) Takes his post.

b. The coupled piece may be partially prepared for action before reaching the firing position. The duties of the cannoneers are the same as in preparing for action when the piece is uncoupled, but only such operations as are practicable are carried out. Immediately after the piece is established in position, preparation for action is completed without command, and the cannoneers take their posts for firing the piece.

c. If PREPARE FOR ACTION has not been ordered before the piece is established in the firing position, the command is habitually given by the chief of section as soon as the piece has been uncoupled. If this is not desired, the caution, "Do not prepare for action," must be given.

■ 17. POSTS OF CANNONEERS, PIECE UNCOUPLED (fig. 5).—*a.* The piece having been uncoupled, posts are taken as follows:

(1) *Chief of section.*—The chief of section goes where he can control the service of the piece, hear commands, and perform his duties effectively. A convenient post is between the trail spades and on line with them.

(2) *Gunner.*—Immediately behind the left wheel and outside the trail.

(3) *No. 1.*—Immediately behind the right wheel and outside the trail.

(4) *No. 2.*—Three feet in rear of the gunner, covering him, and inside the trail.

(5) *No. 3.*—Two feet to the left of No. 2.

(6) *No. 4.*—Two feet in rear of No. 3, covering him.

(7) *No. 5.*—Two feet to the left of No. 4.

(8) *No. 6.*—Two feet to the left of No. 5.

(9) *No. 7.*—Two feet in rear of No. 5, covering him.

b. At drill all stand at attention at their posts facing the front. In firing and combat, minor modifications of these posts are required for the more efficient performance of the duties in the service of the piece, and for protection of the personnel. Higher-numbered cannoneers, if present, take posts as prescribed by the chief of section.

c. In order to exercise the cannoneers in all the duties connected with the service of the piece and to lend variety to the drill, the posts of individual cannoneers should be changed frequently. The cannoneers being at their posts, howitzer coupled or uncoupled, the command is: 1. CHANGE POSTS, 2. MARCH. In each squad No. 1 quickly takes the post of No. 2, No. 2 of No. 3, and so on, No. 7 taking the post of No. 1. The gunner and higher-numbered cannoneers change only when specifically directed; the command is: 1. GUNNER AND CANNONEERS CHANGE POSTS, 2. MARCH. In each squad, the gunner quickly takes the post of No. 1, No. 1 of No. 2, and so on. The highest-numbered cannoneer takes the post of the gunner.

■ 18. MARCH ORDER.—*a.* The howitzer being uncoupled and prepared for action, to resume the order for marching, the

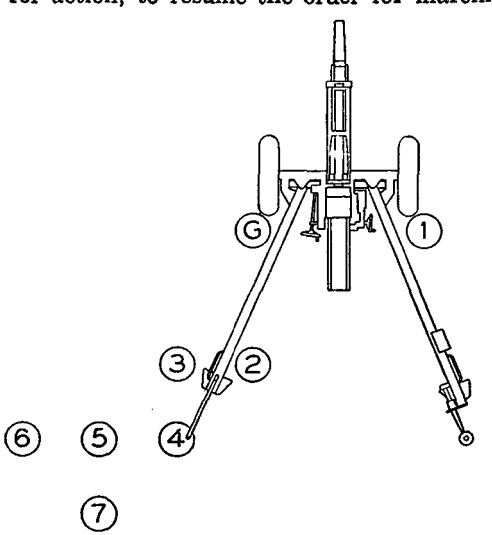


FIGURE 5.—Posts of cannoneers, howitzer uncoupled.

command is: MARCH ORDER. Duties of individuals are as follows:

(1) *Chief of section.*—(*a*) Supervises the work of the cannoneers.

(*b*) Inspects the matériel; makes sure that the piece is not loaded and that the traveling lock and cradle lock are locked in the traveling position; and, when the operations have been completed, reports to the executive, "Sir, No. (so-and-so) in order," or reports any defects which the section cannot remedy without delay.

(2) *Gunner.*—(*a*) Places the piece in the center of traverse.

(*b*) Removes left trail lock pin from the firing position and places it in the traveling position.

(*c*) Sets the rotating head and deflection at zero and closes the covers on the telescope mount leveling bubbles.

(*d*) Removes the telescope from the mount, returns it to its case, and locks the case.

(*e*) Replaces the breech end of the howitzer cover, assisted by No. 1.

(*f*) Takes his post.

(3) *No. 1.*—(*a*) Operates elevation handwheel to assist No. 4 in locking cradle lock.

(*b*) Removes the right trail lock pin from the firing position and places it in traveling position.

(*c*) Inspects the chamber to see that piece is unloaded and closes breech.

(*d*) Locks the traveling lock, after the trails have been closed and locked.

(*e*) Assists the gunner in replacing the breech end of the howitzer cover.

(*f*) Takes his post.

(4) *No. 2.*—(*a*) Closes the left trail, assisted by No. 6.

(*b*) Disassembles the rammer staff; removes the rammer (bore brush) and places it in the section chest; secures the rammer staff in its traveling position on the trail.

(*c*) Takes his post.

(5) *No. 3.*—(*a*) Closes the right trail, assisted by No. 7.

(*b*) Turns and locks the drawbar in its traveling position.

(*c*) Places the fuze setter in the section chest.

(*d*) Prepares ammunition and tools, assisted by Nos. 4, 5, 6, and 7, for loading in the prime mover.

(*e*) Takes his post.

(6) *No. 4.*—(*a*) Locks the cradle lock in the traveling position, assisted by No. 1 operating the elevation handwheel.

(*b*) Locks the left axle lock in the traveling position.

(*c*) Raises and locks the left top shield, if down.

(*d*) Replaces the muzzle end of the howitzer cover, assisted by No. 5.

(*e*) Assists No. 3 in preparing the ammunition and tools for loading in the prime mover.

(*f*) Takes his post.

(7) *No. 5.*—(*a*) Locks the right axle lock in the traveling position.

(*b*) Assists No. 4 in replacing the muzzle end of the howitzer cover.

(*c*) Secures the aiming posts in the traveling position on the trail.

(*d*) Assists No. 3 in preparing the ammunition and tools for loading in the prime mover.

(*e*) Takes his post.

(8) *No. 6.*—(*a*) Assists No. 2 in closing the left trail.

(*b*) Assisted by No. 7, locks trail lock.

(*c*) Removes the trail handspike from the left trail and secures it in its traveling position.

(*d*) Prepares the section chest for loading in the prime mover, assisted by No. 7.

(*e*) Assists No. 3 in preparing the ammunition and tools for loading in the prime mover.

(*f*) Takes his post.

(9) *No. 7.*—(*a*) Assists No. 3 in closing the right trail.

(*b*) Assists No. 6 in locking the trail lock.

(*c*) Assists No. 3 in placing the drawbar in the traveling position.

(*d*) Assists No. 6 in preparing the section chest for loading in the prime mover.

(*e*) Assists No. 3 in preparing the ammunition and tools for loading in the prime mover.

(*f*) Takes his post.

b. To resume fire in another position.—(1) If firing is to be resumed shortly in another position to which the piece must be towed by its prime mover, the command MARCH ORDER is not given. In this case, at the command for coupling, only such of the operations incident to march order are per-

formed as are necessary for the movement of the piece and for the care and security of the equipment.

(2) If the command MARCH ORDER is given while the piece is coupled, the operations pertaining to march order are completed.

SECTION VII

DUTIES IN FIRING

■ 19. GENERAL.—In general the duties in firing are as follows:

a. The chief of section is responsible that all duties are properly performed, all commands executed, and all safety precautions observed.

b. The gunner sets the announced deflection, lays for direction, and refers the piece.

c. No. 1 sets the announced site and range (elevation), opens and closes the breech, and fires the piece.

d. No. 2 loads the piece.

e. No. 3 operates the fuze setter and makes the proper setting of fuzes.

f. No. 4 assists No. 3 in setting fuzes, and passes the rounds to No. 2 for loading.

g. No. 5, assisted by Nos. 6 and 7, prepares charges and passes the reassembled round to No. 4.

h. Nos. 6 and 7 remove ammunition from the containers and assist No. 5 in preparing charges and reassembling rounds. No. 7 keeps empty cartridge cases out of the way of the cannoneers.

■ 20. CHIEF OF SECTION.—*a. Enumeration of duties.*—(1) To lay for elevation, assisted by No. 1, when the gunner's quadrant is used.

(2) To measure the elevation (range).

(3) (*a*) To measure the minimum quadrant elevation.

(*b*) To measure the minimum range (elevation).

(4) To indicate to the gunner the aiming point, the referring point, or the target.

(5) To follow fire commands.

(6) To indicate when the piece is ready to fire.

(7) To give the command to fire except when firing on moving targets with direct laying.

(8) To report errors and other unusual incidents of fire to the executive.

(9) To conduct prearranged firing schedules.

(10) To record basic data.

(11) To observe and frequently check the functioning of the matériel.

(12) To assign duties when firing with reduced personnel.

(13) To conduct the fire of his piece on a moving target when so ordered by the executive.

b. Detailed description of certain duties.—(1) *To lay for elevation when gunner's quadrant is used.*—(*a*) The command QUADRANT (SO MUCH) indicates that the gunner's quadrant is to be used.

(*b*) To set an elevation on the gunner's quadrant, for example, 361.8 mils, the chief of section sets the upper edge of the head of the index arm opposite the 360 mark of the graduated arc on the quadrant frame; he then slides the slide level along the index arm until the index of the slide level is opposite the 1.8 mark of the scale on the index arm. In setting the slide, the chief of section must be careful to use the scale on the index arm which is on the same side of the quadrant as the graduated arc he used in setting the index arm at 360 mils. After he has set the slide, he tightens the clamp just enough to hold the slide in place.

(*c*) The announced elevation having been set on the gunner's quadrant, the piece loaded, and the breechblock closed, the chief of section places the quadrant on the quadrant seat, with the words "line of fire" at the bottom and the arrow pointing toward the muzzle. The chief of section must be sure to use the arrow which appears on the same side of the quadrant as the scale which he is using. He stands squarely opposite the side of the quadrant and holds it firmly on the quadrant seat, parallel to the axis of the bore. It is important that he take the same position and hold the quadrant in the same manner for each subsequent setting, so that in each case he will view the quadrant bubble from the same angle.

(*d*) No. 1 operates the elevating handwheel until the quadrant bubble is centered, making sure that the last movement is in the direction in which it is most difficult to turn the handwheel. The chief of section warns No. 1 when the bubble is approaching the center, in order that the final centering may be performed accurately.

(2) *To measure elevation (range).*—At the command MEASURE THE ELEVATION (RANGE), the piece having been laid,

the chief of section causes No. 1 to set site 300 and, with the elevating knob, to level the range quadrant elevating bubble. The chief of section then reads the elevation (range) set on the elevation scale (range drum) and announces the elevation (range) thus set; for example, "Elevation (range) No. (so-and-so), (so much)."

(3) *To measure minimum quadrant elevation or minimum elevation (range).*—(*a*) *Quadrant elevation.*—The command is: MEASURE THE MINIMUM QUADRANT ELEVATION. The chief of section, sighting along the lowest element of the bore, causes No. 1 to operate the elevating mechanism until the line of sight just clears the crest. He then measures the quadrant elevation and, after reading the angle on the quadrant, reports it to the executive thus: "Minimum quadrant elevation No. (so-and-so), (so much)."

(*b*) *Elevation.*—The command is: MEASURE THE MINIMUM ELEVATION, SITE (SO MUCH).—The chief of section causes No. 1 to set the site announced. Then, sighting along the lowest element of the bore, he causes No. 1 to operate the elevating handwheel until the line of sight just clears the crest. No. 1 then levels the bubble of the range quadrant by turning the elevating knob. The chief of section reads the elevation setting and reports it to the executive thus: "Minimum elevation No. (so-and-so), (so much), site (so much)."

(*c*) *Range.*—The command is: MEASURE THE MINIMUM RANGE, CHARGE (SO-AND-SO), SITE (SO MUCH). The chief of section causes No. 1 to install the range drum for the announced charge, and to set the site announced. Then, sighting along the lowest element of the bore, he causes No. 1 to operate the elevating handwheel until the line of sight just clears the crest. No. 1 then levels the bubble of the range quadrant by turning the elevating knob. The chief of section reads the range setting and reports it to the executive thus: "Minimum range, No. (so-and-so), (so much), charge (so-and-so), site (so much)."

(*d*) When the executive announces the minimum quadrant elevation or the minimum elevation (range), charge, and site, the chief of section records it in a notebook and causes the gunner to chalk it on a convenient place on the carriage.

(4) *To indicate to gunner the aiming point, referring point, or target.*—Whenever an aiming point, a referring point, or

a target has been designated by the executive, the chief of section will make sure that he has properly identified the point in question. He will then indicate it to the gunner. If there is any possibility of misunderstanding, the chief of section will turn the telescope until the horizontal and vertical hairs are on the point designated.

(5) *To follow fire commands.*—The chief of section will follow the fire commands mentally. He will not repeat the commands, but will be prepared to give any element of the last command to any cannoneer who has failed to hear it.

(6) *To indicate when piece is ready to fire.*—When the executive can see arm signals of the chief of section, the chief of section will extend his right arm vertically as a signal that the piece is ready to fire. He gives the signal as soon as the gunner calls "Ready." When arm signals cannot be seen, the chief of section reports orally to the executive, "No. (so-and-so) ready."

(7) *To give command to fire.*—When No. 1 can see arm signals made by the chief of section, the chief of section will give the command to fire by dropping his right arm sharply to his side. When his arm signals cannot be seen, he orally commands: NO. (SO-AND-SO) FIRE. The chief of section will not give the signal or command to fire until all the cannoneers are in their proper places. He will require the cannoneers to stand clear of the piece for the first round.

(8) *To report errors and other unusual incidents of fire to executive.*—If for any reason the piece cannot be fired, the chief of section will promptly report that fact to the executive, and the reason therefor; for example, "No. (so-and-so) out, misfire." Whenever it is discovered that the piece has been fired with an error in laying, the chief of section will report that fact at once; for example, "No. (so-and-so) fired with incorrect deflection." Whenever the gunner reports that the aiming posts are out of alinement with the telescope, the chief of section will report that fact and request instructions. Likewise, he promptly reports other unusual incidents that affect the service of the piece. (See par. 33.)

(9) *To conduct prearranged fire schedules.*—Whenever the execution of prearranged fire schedules is ordered, the chief of section will conduct the fire of his section in strict conformity to the schedule prescribed.

(10) *To record basic data.*—The chief of section will record

in a notebook data of a semipermanent nature. These include such data as minimum elevations; base deflections, including aiming points used; prearranged fires when prepared schedules are not furnished; safety limits in elevation and deflection; number of rounds fired, with the date and hour; and calibration corrections when appropriate.

(11) *To observe and check functioning of matériel.*—The chief of section closely observes the functioning of all parts of the matériel during firing. Before the piece is fired, he verifies the fact that the recoil mechanism contains the proper amount of oil; thereafter he carefully observes the functioning of the recoil system. He promptly reports to the executive any evidence of trouble (par. 46).

(12) *To assign duties when firing with reduced personnel.*—Whenever the personnel of the section serving the piece is temporarily reduced in numbers below that indicated in this manual, the chief of section will make such redistribution of duties as will best facilitate the service of the piece.

(13) *During direct laying on moving target, to conduct fire of his piece when so ordered by executive.*—(*a*) *Initial lead.*—The chief of section observes the target, estimates its lateral speed, and (based on the speed) estimates the lead in target lengths.

(*b*) *Initial range or elevation.*—The chief of section estimates the initial range to the target and announces the range or the corresponding elevation. The announced range is used by the gunner when he lays for range (par. 21*b*(8)) and by No. 1 when he lays for range using the elbow telescope (par. 22*b*(2)(*b*)). The announced elevation is used by No. 1 in laying for elevation (par. 22*b*(3)(*b*)). The chief of section announces the elevation which is the algebraic sum of the range elevation and angle of site. For rapid determination of the elevation he should be furnished with a tabulated card for Charge VII, showing the elevation setting for plus and minus angles of site and ranges for which such fire may be used. He is trained to determine the range and measure the site to various points in the sector from which enemy combat vehicles may be expected to appear. These are recorded and should be memorized by him. They are used in determining the initial elevation announced.

(*c*) *To announce an initial range (elevation) and lead.*—The command is: TARGET (SO-AND-SO), RANGE (ELE-

VATION) (SO MUCH), LEAD (SO MANY) TARGET LENGTHS.

(*d*) *To announce a change in range (elevation) and lead.*—The chief of section observes the fire of his piece, and when the gunner or No. 1 is not tracking the target effectively, he announces a range change or a new lead. The announced change in range or elevation is given in yards. The command is: UP (DOWN) (SO MUCH). The announced change in lead is given as a new lead in the number of target lengths. The command is: LEAD (SO MANY).

■ 21. GUNNER.—*a. Enumeration of duties.*—(1) (*a*) To center the bubbles on the telescope mount.

(*b*) To set or change the deflection.

(*c*) To apply the deflection difference.

(*d*) To lay for direction.

(*e*) To call "Ready."

(*f*) To refer the piece.

(*g*) To record base deflection.

(*h*) To measure a deflection.

(*i*) To take and maintain an announced lead during direct laying on a moving target.

(*j*) When directed, to lay for range as well as direction, during direct laying on a moving target.

(*k*) To give the command to fire during direct laying on a moving target.

(2) For indirect laying or direct laying on a stationary target, the gunner performs the duties prescribed in (1) (*a*), (*b*), (*c*), (*d*), and (*e*) above.

(3) For direct laying on a moving target, the gunner performs the duties prescribed in (1) (*a*), (*i*), and (*k*) and, when directed, in (*j*) above.

(4) When directed, the gunner performs the duties prescribed in (1) (*f*), (*g*) and (*h*) above.

b. Detailed description of certain duties.—(1) *To set or change deflection.*—(*a*) *To set deflection.*—At the command, for example, DEFLECTION, 1,885, the gunner first sets the zero of the azimuth micrometer opposite the fixed index, if it is not already so set. He then pushes the throw-out lever and turns the rotating head until the hundreds' graduation (18 in this case) is opposite the azimuth-scale index. He then releases the throw-out lever and, grasping the deflection

knob with his left hand, with the thumb on top, turns the knob to the left until the micrometer index is opposite the graduation 85 of the counterclockwise graduations on the azimuth micrometer. The line of sight will then make a horizontal angle of 1,885 mils with the axis of the bore. He then turns the azimuth micrometer until its zero graduation is opposite the micrometer index. Any movement of the azimuth micrometer does not change a deflection previously set.

(*b*) *To change deflection.*—The gunner should be trained always to grasp the deflection knob with his left thumb on top, as then the command for changing the deflection will indicate the direction in which he should move his thumb in turning the knob. He also should be taught that turning the knob to the right decreases the deflection set on the telescope and results in moving the muzzle to the right when the piece is laid with the new deflection. Similarly, he should be taught that turning the knob to the left increases the deflection and results in moving the muzzle to the left when the piece is laid. The deflection having been set at 1,885 mils, if a subsequent command is given, for example, RIGHT 65, the gunner turns the deflection knob by moving his thumb to the right until the micrometer index has moved from zero to 65 on the clockwise graduations of the azimuth micrometer. As turning the deflection knob to the right decreases the deflection, the resulting deflection will be 1,820 mils. The azimuth micrometer is then reset with its zero opposite the micrometer index. Should the command be LEFT (SO MUCH), the gunner changes the deflection setting in the same manner, except that he moves his thumb to the left and follows the counterclockwise graduations of the azimuth micrometer.

(2) *To apply deflection difference.*—(*a*) The command is: ON NO. (SO-AND-SO) OPEN (CLOSE) (SO MUCH). The gunner of the piece indicated in the command does not change the deflection set on his telescope. Each of the other gunners changes his deflection setting by the number of mils specified in the command if his piece is next in line to the piece indicated; by twice this number of mils if his piece is second in line from the piece indicated; by three times this number of mils if his piece is third in line from the piece indicated.

(*b*) If the command is, for example, ON NO. 1 OPEN 5, the gunner on No. 1 makes no change; the gunner on No. 2 turns the deflection knob by moving his thumb to the left (away from the piece indicated in the command), and sets off 5 mils once; the gunner on No. 3 turns the deflection knob in the same manner, and sets off 5 mils twice, or a total of 10 mils; the gunner on No. 4 turns his deflection knob in the same manner, and sets off 5 mils three times, or a total of 15 mils. It is recommended that gunners be taught to use the telescope as an adding machine, instead of totaling the shifts.

(*c*) Should the command be, for example, ON NO. 3 CLOSE 10, the gunner on No. 1 turns the deflection knob by moving his thumb to the left (toward the piece indicated in the command), and sets off 10 mils twice, or a total of 20 mils; the gunner on No. 2 turns his deflection knob in the same manner, and sets off 10 mils once; the gunner on No. 3 makes no change; the gunner on No. 4 turns his deflection knob by moving his thumb to the right and sets off 10 mils once.

(*d*) It should be noted that in making the deflection changes involved in applying the deflection difference, each gunner turns the deflection knob by moving his thumb away from the piece indicated if the command is OPEN, and toward the piece indicated if the command is CLOSE; also that the muzzles of the pieces will be moved in similar directions when the pieces are laid after the deflection differences have been set.

(*e*) When a deflection change and a deflection difference are announced at the same time, for example, RIGHT 30, ON NO. 1 CLOSE 5, both of which affect the gunner's piece, he should first set off the deflection change and then apply the deflection difference.

(*f*) In the methods described above, it is implied that the gunner resets the azimuth micrometer with its zero opposite the micrometer index each time the deflection knob has been turned. If he does so, he starts each change in the deflection setting with the micrometer index at zero. This facilitates setting off the tens and units on the azimuth-micrometer scales. It is important that the gunner, before turning the deflection knob, verify the setting of the azimuth micrometer

to make sure that its zero coincides with the micrometer index.

(3) *To lay for direction.*—(*a*) *Indirect laying.*—The deflection having been set, the gunner brings the vertical hair of the panoramic telescope on the aiming point by traversing the piece. If the amount of movement necessary is greater than can be obtained by traversing, the trails must be shifted. To have the trails shifted, the gunner commands or signals: MUZZLE RIGHT (LEFT). No. 2 and No. 6 on the left trail handspike and No. 3 and No. 7 on the drawbar on the right trail then shift the trails so that the muzzle moves in the indicated direction. They stop shifting when commanded or signaled to stop by the gunner. The gunner then completes the laying by bringing the vertical hair of the telescope on the aiming point.

(*b*) *Direct laying on stationary target.*—The deflection having been set, the gunner traverses the piece by means of the traversing handwheel until the vertical hair of the telescope is on his part of the target. If the amount of movement necessary to lay on the target is greater than can be obtained by traversing, the trails must be shifted ((*a*) above).

(*c*) *Direct laying on moving target.*—See (8) below.

(*d*) *Procedure to insure accuracy.*—To take up lost motion, the final movement of the traversing handwheel should be such as to cause the vertical hair of the telescope to approach the aiming point from the left. The gunner should habitually lay with the vertical hair of the telescope on exactly the same portion of the aiming point or target and insure that the cross-level bubble is centered for each round.

(4) *To call "Ready."*—The piece having been laid for direction, and No. 1 having called "Set," the gunner verifies the laying, moves his head clear of the telescope, and calls "Ready" to indicate that the piece is ready to be fired.

(5) *To refer piece.*—The piece having been laid for direction, to refer the piece, the command is: 1. AIMING POINT (SO-AND-SO), 2. REFER. Without disturbing the laying of the piece, the gunner brings the vertical hair of the telescope on the new aiming point (referring point). He then reads and announces the deflection thus set. Two referring points ordinarily are used, one for day and the other for night. A referring point should be at least 50 yards from the telescope. Frequently the aiming posts will have to be used as referring

points, particularly at night. The chief of section records the deflection and a description of each referring point in his notebook. The gunner records the deflection and referring point in current use on a convenient part of the carriage.

(6) *To record base deflection.*—At the command RECORD BASE DEFLECTION, the gunner records the deflection set on his telescope upon some convenient part of the carriage or upon a data board (par. 40).

(7) *To measure a deflection.*—The command is: 1. AIMING POINT (SO-AND-SO), 2. MEASURE THE DEFLECTION. The piece having been established in direction, the gunner turns the telescope until the vertical hair is on the aiming point. He then reads and announces the deflection.

(8) *For direct laying on moving target, to take and maintain an announced lead.*—The command is: TARGET (SO-AND-SO), RANGE (SO MUCH), LEAD (SO MANY) TARGET LENGTHS. The gunner sets his azimuth scale at zero and tracks the target with the traversing handwheel, keeping the vertical hair of the telescope ahead of the target by measuring the announced lead on the reticle scale. When time does not permit the chief of section to announce the lead, it is determined by the gunner.

(9) *To lay for both direction and range on moving target.*—When required by the situation, the gunner will lay for both direction and range on a moving target. He sets scales of the rotating head of the telescope and the azimuth scale at zero. He brings into coincidence the arrows indicating the position of the telescope mount which brings the line of sighting parallel to the axis of the bore. He then tracks the target with the traversing and elevating handwheels, keeping the vertical hair of the telescope ahead of the target by measuring the announced lead on the reticle scale, and placing the corresponding range line of the announced range on the base of the target. He gives the command FIRE when he is laid. When time does not permit the chief of section to announce the range and lead, the gunner determines them.

■ 22. No. 1.—*a. Enumeration of duties.*—(1) (*a*) To set the angle of site.

(*b*) To set the range.

(*c*) To set the elevation.

(*d*) To lay for elevation (range).

(*e*) Tc open and close the breech.

(*f*) To call "Set."

(*g*) To fire the piece.

(*h*) To use the rammer.

(2) For indirect laying or direct laying on a stationary target, No. 1 performs all of the duties prescribed in (1) above.

(3) For direct laying on a moving target, No. 1 performs the duties prescribed in (1) above, except that when the gunner lays for range as well as direction, No. 1 performs only the duties prescribed in (1) (*e*), (*f*), (*g*), and (*h*).

b. Detailed description of certain duties.—(1) *To set angle of site.*—No. 1 is first taught to read angles of site on the angle-of-site scale and then to set angles of site. To set an angle of site, No. 1 turns the angle-of-site knob until the announced site is shown. The angle of site is indicated by a scale graduated in hundreds of mils from 0 to 6 and a micrometer scale graduated in mils. A site of 300 is horizontal. No. 1 first sets the index in the proper section of the scale in hundreds of mils and then sets the units on the micrometer scale. The last motion in setting the angle of site should be in the direction of increasing site.

(2) *To set range.*—(*a*) *Using range drum.*—No. 1 is first taught to read ranges on the range drum and then to set ranges. To set the range, No. 1 installs the range drum corresponding to the announced charge; he then turns the elevating knob until the announced range is opposite the index, making sure that the last movement is in the direction of increasing range.

(*b*) *Using elbow telescope.*—In direct laying, when so directed, he sets the range (with the correct angle of site automatically applied) by using the appropriate range line in the reticule of the elbow telescope. No. 1, using the elevating handwheel, keeps the range line corresponding to the announced range on the base of the target.

(3) *To set elevation.*—(*a*) *Indirect laying.*—No. 1 is first taught to read elevations on the elevation scale and then to set elevations. To set an elevation, No. 1 sets the angle of site at 300 (or at an announced site) and sets the announced elevation on the elevation scale. The elevation is indicated by a scale graduated in hundreds of mils from minus 100 to plus 1,200 and a micrometer scale graduated from zero to 100 mils. No. 1 grasps the elevating knob and turns it until

the announced elevation is shown, making sure that the last movement is in the direction of increasing elevation.

(*b*) *Direct laying on moving targets.*—At the command TARGET (SO-AND-SO), ELEVATION (SO MUCH), LEAD (SO MANY) TARGET LENGTHS, No. 1 sets the angle of site at 300 and the announced elevation on the elevation scale ((*a*) above) and then lays for elevation ((4) below). Announced changes in elevation are given in yards, for example, DOWN, 50. No. 1 having been trained to know the effect in range resulting from turning the elevating handwheel, follows the announced range changes by this method, without further reference to the initial elevation setting.

(4) *To lay for elevation (range).*—No. 1 turns the cross-level knob and levels the cross-level bubble. Having performed the duties described in (1) and (2)(*a*), or (3) above, he turns the elevating handwheel and elevates or depresses the piece until the elevation bubble is level, making sure that the last movement is in the direction in which it is most difficult to turn the handwheel.

(5) *To open and close breech.*—(*a*) *To open breech.*—No. 1 grasps the breech operating lever handle, pushes down on the handle to release the catch, and draws it toward him and to the rear, opening the breech.

(*b*) *To close breech.*—No. 1 grasps the operating handle and pushes it forward and away from him until the breech is closed and the latch is engaged.

(*c*) *Fire on moving targets.*

1. In fire on moving targets when the gunner lays for range as well as direction, No. 1 performs the duties prescribed in (*a*) and (*b*) above.
2. When No. 1 lays for range using the elbow telescope, No. 5 opens and closes the breech and fires the piece.

(6) *To call "Set."*—No. 1 calls "Set" when the piece has been loaded, the breech closed, and the piece laid for site and elevation.

(7) *To fire piece.*—In indirect laying, at the chief of section's command, "No. (so-and-so) fire," or in direct laying on a moving target when the gunner is laying for direction and range, at the gunner's command "Fire," No. 1 grasps the handle of the lanyard and pulls it away from the piece as far as possible. Under no circumstances will No. 1 grasp

the lanyard until the gunner calls "Ready." When the chief of section gives the command "Stand clear" (for the first round), No. 1 steps clear of the wheel and at the command or signal, "Fire," leans forward, grasps the handle of the lanyard, and fires the piece. If the chief of section commands "With the long lanyard," No. 1 attaches the long lanyard to the short lanyard and fires as previously described. In case of a misfire, the instructions contained in paragraph 38 will be followed.

(8) *To use rammer.*—The rammer (bore brush) will be handled by No. 1 only. The rammer and rammer staff are used to extract unfired rounds or cartridge cases which cannot be ejected by the extractor. To extract a cartridge case, No. 1 removes the rammer (bore brush) from the rammer staff, inserts the rammer staff in the bore, and lightly taps the bottom of the inside of the case until it is loosened and can be pushed out of the chamber. No. 2, standing at the breech, receives the cartridge case in both hands. To extract an unfired round, the procedure described in paragraph 37 will be followed.

■ 23. No. 2.—*a. Enumeration of duties.*—(1) To load the piece.

(2) In volley fire, to call out the number of the round.

(3) When necessary, to assist No. 6 in shifting the left trail.

(4) To inspect the chamber and bore frequently to find out whether there is any residue from the charge.

b. Detailed description of certain duties.—(1) *To load the piece.*—To receive the round, No. 2 steps with his left foot toward No. 4 and grasps the round with his right hand at the base of the cartridge case and his left hand in front of the rotating band. After resuming his position facing the gunner, he inserts the round in the breech and pushes it home with his right hand. He must use care, especially at higher elevations, to avoid injuring his hand. When necessary to insert his hand into the breech recess, to push the round home, he should first close his fist. No. 2 will be particularly careful to avoid striking the fuze against any portion of the piece. To prevent premature bursts caused by fuzes in projectiles being struck by the piece in recoil, a round to be loaded will be held well out of the path of the recoil until the gun is again in battery (AR 750–10).

(2) *To call out the number of the round.*—To insure that the correct number of rounds is fired in volley fire, No. 2 calls out the range and the number of the round as he loads the piece, and, as he loads the last round, adds "Last round." For example, when two rounds are to be fired at 2,800, he calls out, "2,800 two, last round." He should not speak louder than is necessary to insure his being heard by the members of his own gun squad.

(3) *When necessary, to assist No. 6 in shifting left trail.*—No. 2 assists No. 6 in shifting the left trail as directed by the gunner. The command is: MUZZLE RIGHT (LEFT), and the trail is shifted in the opposite direction so that the muzzle is swung in the direction indicated. At the gunner's command or signal to stop shifting, Nos. 2 and 6 lower the trail to the ground.

(4) *To inspect chamber and bore frequently to find out whether there is any residue from charge.*—No. 2 will inspect the chamber and bore frequently, particularly when firing in the lower zones and at low elevations, to make certain that no residue from the charge, which might cause jamming of the round in loading, remains in the chamber or bore.

■ 24. No. 3.—*a. Enumeration of duties.*—(1) To make the prescribed setting of impact fuzes.

(2) To set the fuze setter.

(3) To set time fuzes.

(4) When necessary, to assist No. 7 in shifting the right trail.

b. Detailed description of certain duties.—(1) *To make prescribed setting of impact fuzes.*—(*a*) The fire commands for opening fire will contain a designation of the setting desired, when the prescribed fuze can be given more than one setting.

(*b*) If the command is FUZE QUICK, No. 3 will verify the setting, and reset to "quick" any fuzes which may be set "delay."

(*c*) After firing is completed, No. 3 will reset to "quick" any fuzes which have been set "delay."

(2) *To set fuze setter.*—The duties of No. 3 in setting the fuzes are as prescribed by the battery executive.

(3) *To set time fuzes.*—The duties of No. 3 in setting time fuzes are as prescribed by the battery executive.

(4) *When necessary, to assist No. 7 in shifting right trail.*—No. 3 assists No. 7 in shifting the right trail as directed by the gunner. The command is: MUZZLE RIGHT (LEFT), and the trail is shifted in the opposite direction so that the muzzle is swung in the direction indicated. At the gunner's command or signal to stop shifting, Nos. 3 and 7 lower the trail to the ground.

■ 25. No. 4.—*a. Enumeration of duties.*—(1) When directed by the gunner, to lower the left top shield and lock it in position.

(2) To assist No. 3 in setting time fuzes.

(3) To pass the round to No. 2.

b. Detailed description of certain duties.—(1) *When directed by gunner, to lower left top shield and lock it in position.*—When the fire commands are such as to require an aiming point (referring point) to the front, No. 4, when directed by the gunner, will promptly lower the left top shield and lock it in the lowered position.

(2) *To assist No. 3 in setting time fuzes.*—See paragraph 24*b*(3).

(3) *To pass round to No. 2.*—No. 4 with his left hand under the cartridge case, his right hand under the projectile, taking care that the projectile and cartridge case do not separate, so passes the round to No. 2 that No. 2 is able to grasp the base of the cartridge case in his right hand.

■ 26. No. 5.—*a. Enumeration of duties.*—(1) To set out the aiming posts.

(2) To prepare charges.

(3) To pass the round to No. 4.

(4) To open and close the breech and fire the piece when those duties are not performed by No. 1.

b. Detailed description of certain duties.—(1) *To set out aiming posts.*—When so directed by the chief of section, No. 5 sets out the aiming posts under the guidance of the gunner (see par. 31).

(2) *To prepare charges.*—The fire commands for opening fire will include the designation of the charge. Unless Charge VII is designated, No. 5, assisted by Nos. 6 and 7, removes the projectile from the cartridge case, withdraws the increments from the cartridge case, and removes those numbered higher than the charge designated. He then replaces the remaining

increments in the cartridge case in their original numerical order and reassembles the projectile to the cartridge case. To disassemble the round, No. 7 grasps the cartridge case near the neck and holds it in a vertical position; No. 6 grasps the body of the projectile and, with a twisting motion, lifts the projectile clear of the cartridge case. After No. 5 has prepared the charge, No. 6, assisted by No. 7, reassembles the projectile to the cartridge case. Care must be used to prevent damage to the lip of the cartridge case.

(3) *To pass round to No. 4.*—No. 5 will pass the round to No. 4 in the most convenient manner.

(4) *To open and close breech and fire piece when those duties are not performed by No. 1.*—When No. 1 lays for range with the elbow telescope or lays for elevation in direct laying against moving targets, No. 5 will take position in rear of No. 1 and will open and close the breech and fire the piece (see par. 22*b*(5) and (7)).

■ 27. No. 6.—*a. Enumeration of duties.*—(1) To remove ammunition from containers.

(2) To assist No. 5 in preparing charges.

(3) When necessary, assisted by No. 2, to shift the left trail.

b. Detailed description of certain duties.—(1) *To remove ammunition from containers.*—Assisted by No. 7, No. 6 removes rounds from their containers and arranges them so that they are within easy reach of No. 5. He inspects each round to see that it is free from sand and dirt and that the rotating band is not burred. With an oily cloth he wipes off any foreign matter. Projectiles with burred rotating bands should be placed aside until he can remove the burrs with a file.

(2) *To assist No. 5 in preparing charges.*—When so directed, No. 6 and No. 7 assist No. 5 in preparing charges as described in paragraph 26*b*(2).

(3) *When necessary, assisted by No. 2, to shift left trail.*—When so directed by the gunner, No. 6, assisted by No. 2, shifts the left rail (see par. 23*b*(3)).

■ 28. No. 7.—*a. Enumeration of duties.*—(1) To assist No. 6 in removing ammunition from containers.

(2) To assist No. 5 in preparing charges.

(3) To keep empty cartridge cases out of the way of the cannoneers.

(4) When necessary, assisted by No. 3, to shift the right trail.

b. Detailed description of certain duties.—(1) *To assist No. 6 in removing ammunition from containers.*—No. 7 assists No. 6 in removing rounds from their containers as described in paragraph 27*b*(1).

(2) *To assist No. 5 in preparing charges.*—No. 7 and No. 6 assist No. 5 in preparing charges as described in paragraph 26*b*(2).

(3) *To keep empty cartridge cases out of way of cannoneers.*—No. 7 piles the empty cartridge cases in rear of the right trail where they will be out of the way of the cannoneers.

(4) *When necessary, assisted by No. 3, to shift right trail.*—When so directed by the gunner, No. 7, assisted by No. 3, shifts the right trail (see par. 24*b*(4)).

SECTION VIII

ADDITIONAL INFORMATION ON THE SERVICE OF THE PIECE

■ 29. ACCURACY IN LAYING.—Sighting and laying instruments, fuze setters, and elevating and traversing mechanisms will be so manipulated as to minimize the effects of lost motion. This requires that last motions in setting instruments and in laying be always in the directions prescribed. The gunner and any other cannoneers who have duties in connection with laying the piece will invariably be required to verify the laying after the breech has been closed.

■ 30. FIRE AT WILL.—The piece being uncovered and prepared for action, in case of sudden attack, when the target appears at a range of less than 600 yards, the executive may command: 1. TARGET (SO-AND-SO), 2. FIRE AT WILL. If a method of close defense has been prearranged, the command is simply FIRE AT WILL. The chief of section repeats the command adding the target designation (when necessary), the range or elevation, and the lead.

a. The methods of fire used in direct laying on moving targets are—

(1) The gunner lays for direction. No. 1 lays for elevation (algebraic sum of range elevation and site). No. 5 opens and closes the breech and fires the piece.

(2) The gunner lays for direction. No. 1 lays for range,

using the elbow telescope. No. 5 opens and closes the breech and fires the piece.

(3) The gunner lays for both direction and range. No. 1 opens and closes the breech and fires the piece.

b. Firing is commenced at the gunner's command FIRE. The piece is loaded and fired as rapidly as possible until the command CEASE FIRING, or until the enemy disappears from view or actually reaches the piece.

■ 31. AIMING POSTS.—When a suitable natural aiming post is not visible, the piece, after it has been laid initially for direction, is referred to the aiming posts as described in paragraph 21*b*(5). Two aiming posts are used for each piece. Each post is equipped with a light for use in firing at night. One post is set up in a convenient location at least 100 yards from the piece. The other post is set up at the midpoint between the first post and the piece, and is lined in by the gunner so that the vertical hair of his telescope and the two aiming posts are all in line. Any lateral displacement of the piece during firing can then be detected easily and corrected as indicated in paragraph 32. For night use, the lights should be adjusted so that the far one will appear several feet higher than the near one; thus the two lights will clearly establish a vertical line on which the vertical hair of the telescope can be laid.

■ 32. DISPLACEMENT CORRECTION.—*a.* When a gunner sees that his aiming posts are out of line, he notifies the chief of section (who notifies the executive) and uses the far post for laying until the piece can be moved or a correction is authorized by the executive. The correction is made by the gunner, who—

(1) Lays on the far post.

(2) Refers to the near post.

(3) Lays on the far post with the new reading.

(4) Reports the new deflection.

(5) Realines the posts (as soon as practicable) by having the near post moved.

b. Lateral displacement is most likely to occur when the axle of the piece is not level.

■ 33. REPORTING ERRORS.—All members of the howitzer squad are trained to report to the chief of section errors in setting

or laying discovered after the command FIRE has been given. The chief of section will immediately report errors to the executive, as prescribed in paragraph 20*b*(8).

■ 34. CEASE FIRING.—The command CEASE FIRING normally is given to the howitzer squad by the chief of section, but in emergencies anyone present may give the command. At this command, regardless of its source, firing will cease immediately. If the piece is loaded, the chief of section will report that fact to the executive. Firing is resumed at the executive's announcement of the range or elevation.

■ 35. SUSPEND FIRING.—The command SUSPEND FIRING is given only when the battery is firing on a prearranged schedule and a temporary halt in the firing is desired. At this command, firing is stopped, but settings continue to be altered in conformity with the schedule. If the piece is loaded, the chief of section will report that fact to the executive. Firing will be resumed at the executive's command RESUME FIRING.

■ 36. CHANGE IN DATA DURING FIRING.—The announcement to the gun squad of any new element of firing data serves as a signal to stop all firing previously ordered but not yet executed. If the piece is not loaded when a new element of firing data is announced, the new data will be set off and firing resumed at the announcement of the range or elevation. If the piece is loaded and the new data require a change in the fuze setting, the chief of section will suspend firing and report to the executive that the piece is loaded. The piece will be unloaded (par. 37) or firing will be resumed only on orders of the executive. (If no change in the fuze setting is required, the new data are set off and the firing is resumed.)

■ 37. TO UNLOAD PIECE.—*a.* When the command UNLOAD is given, No. 1 opens the breech slowly. No. 2, standing at the breech, receives the ejected round or cartridge case.

b. Should the extractor fail to eject the complete round, the assembled staff and rammer (or staff and unloading device, if available) is used. An officer sees that the recess in the head of the rammer or device is free from obstructions. Under the direct supervision of an officer, No. 1 inserts the rammer or device in the bore until the head encloses the fuze and comes in contact with the projectile. He pushes and, if

necessary, taps the rammer staff lightly until the round is dislodged from its seat. He then pushes it out of the breech; No. 2 receives it.

c. If the extractor has ejected the cartridge case but not the projectile, No. 1 fills the chamber with waste and closes the breechblock. He dislodges the projectile as prescribed in *b* above. No. 2 then opens the breech, removes the waste, and receives the projectile as No. 1 pushes it to the rear.

d. When practicable, the procedure prescribed in TM 9–1900 should be followed.

■ 38. MISFIRES.—In the event of a misfire, at least three attempts to fire the primer will be made. After at least 2 minutes have elapsed since the last attempt to fire the primer the executive will command UNLOAD. The procedure is the same as in paragraph 37*a*. If the extractor ejects the round, the round will be disposed of as prescribed in TM 9–1900. If the extractor ejects only the cartridge case (which will happen most frequently), the case will be immediately thrown clear of all personnel to prevent injury in case of a hangfire. Another cartridge case with the proper charge will be inserted in the breech, care being taken not to damage the case. Authority to fire the round will be obtained from the officer conducting fire.

■ 39. AMMUNITION. — Ammunition must be protected from damage, especially the rotating bands and cartridge cases. It is sorted and stored by lots. It is kept in containers as long as practicable. Whether in or out of containers, it is protected from dirt and ground moisture by being placed on paulins or raised off the ground. It is protected from sun and rain by a paulin or other shelter placed above it. The powder temperature is kept uniform for any one lot; to permit free circulation of air, wood or brush is placed between layers of unboxed rounds. If time permits, trenches for ammunition will be dug to minimize the effects of a direct hit. The ammunition is stacked, with each stack containing not more than 75 rounds and being not more than 4 layers high. Stacks are at least 10 yards apart.

■ 40. SECTION DATA BOARD.—When positions are occupied for more than a few hours, each chief of section should maintain a section data board on which he records such items as base

deflection, calibration corrections when appropriate, minimum range or elevation, data for primary defensive fire missions, and other data the need for which may be urgent.

SECTION IX

CARE AND MAINTENANCE OF MATÉRIEL

41. GENERAL.—*a.* This section covers such operations in the care and maintenance of matériel as may be performed by a battery in the field.

b. Complete instructions for battery maintenace, including disassemblies, are found in the Technical Manuals and Standard Nomenclature Lists referred to in paragraph 2, especially TM 9–325 and SNL C–21. Operations not covered in those publications are performed by ordnance personnel.

c. In general, the battery is charged with preventive maintenance; that is, with routine cleaning, lubricating, and preserving. Also, certain classes of repairs, adjustments, and replacement of parts may be made under the direction of an officer or the chief mechanic. Parts which may be drawn by a battery for replacement purposes are indicated in SNL C–21 by the symbol %, and unless specifically prohibited, such parts may be installed by the battery mechanic. For routine care and maintenance, specific duties are assigned to individuals or gun squads, and a strict accountability for the proper performance of such duties is enforced.

d. The following operations may be performed within the battery:

(1) Draining and replenishing the recoil liquid.

(2) Dismounting the howitzer from the sleigh.

(3) Dismounting the sleigh from the cradle.

(4) Removal, disassembly, and replacement of parts of the breech, operating, and firing mechanisms.

(5) Removal of the equilibrator for cleaning and lubricating.

(6) Removal, care, and maintenance of wheels, wheel bearings, and tires.

(7) Maintenance and adjustment of the brake mechanism.

(8) Replacement of minor parts or assemblies indicated by the symbol % in Standard Nomenclature List C–21.

■ 42. INSPECTION.—Regulations do not require that periodic inspections of ordnance matériel be made by field artillery troops. However, the battery executive should make a daily general inspection and, following the monthly lubrication period, he should make a detailed inspection of the matériel. The purpose of the daily inspection is to insure that the battery is properly performing its preventive maintenance functions. For this purpose, a general inspection of the weapon for appearance and a spot check of one or two parts of the weapon for mechanical functioning are deemed sufficient. The parts selected for spot check should be varied from day to day in order to insure a check of all parts of the weapon. At the monthly inspection all personnel of the firing battery should be present. The executive should make a thorough mechanical inspection of all weapons and an inspection of ordnance tools, spare parts, and equipment for condition and for completeness of the sets. The artillery mechanic should accompany the executive at the mechanical inspection of the weapons. All necessary repairs or adjustments which may be performed by the mechanic should be accomplished; all other necessary repairs or adjustments should be reported to ordnance personnel. In addition to the two inspections referred to above, there should be frequent inspections by battery, battalion, and regimental commanders, at which times the complete battery allowances should be displayed and inspected. These command inspections insure, in general, only that the appearance and completeness of equipment are maintained at the prescribed standard. General instructions concerning the inspection of this matériel are found in section VI, TM 9–325.

■ 43. CLEANING.—*a.* Dirt and grit accumulated in traveling or from the blast of the piece in firing settle on the bearing surfaces, and in combination with the lubricant form a cutting compound. Primer fouling attracts moisture and hastens the formation of rust. During lulls in firing and immediately after firing, the piece must be thoroughly cleaned. At other times it should be cleaned at intervals not exceeding 2 weeks, depending upon the use and condition. Dirt on nonbearing surfaces can usually be removed by water; lubricated or other greasy parts must be cleaned with dry-cleaning solvent applied with a rag. The procedure in cleaning

the bore and breech mechanism is described in paragraphs 47 and 48. The following cleaning materials are issued by the Ordnance Department for use in the field:

(1) *Soda ash (dehydrated sal soda).*—Used for cleaning the bore, breech mechanism, and firing mechanism after firing.

(2) *Dry-cleaning solvent.*—For removing grease. It is preferred to kerosene because it does not leave a corrosive film, and to gasoline because it is less inflammable.

(3) *Crocus cloth.*—This is the coarsest abrasive permitted for cleaning rust and stains from bearing surfaces.

(4) *Emery cloth.*—Used for cleaning unfinished or non-bearing steel surfaces only. Issued in five degrees of coarseness, of which 00 is the finest.

(5) *Burlap, jute.*—Issued for cleaning the bore.

(6) *Cotton waste, clean rags, and sponges.*—For general cleaning purposes.

b. A division of duties for members of the gun squad in routine cleaning and maintenance is as follows:

(1) *Gunner.*—Telescope, telescope mount, and gunner's quadrant.

(2) *No. 1.*—Range quadrant, elbow telescope and mount, and firing mechanism.

(3) *No. 2.*—Breech mechanism and firing lock.

(4) *No. 3.*—Fuze setter.

(5) *Nos. 4, 5, 6, and 7.*—Bore, elevating and traversing mechanisms, and recoil slides.

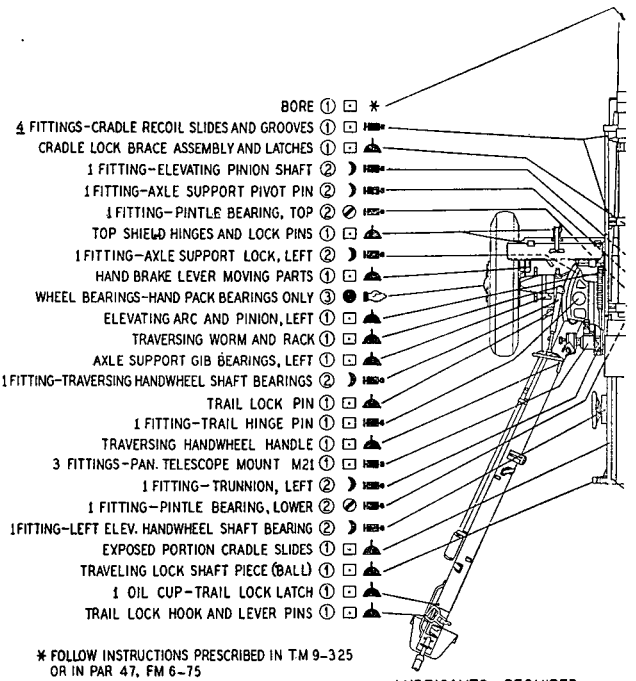
(6) *Other cannoneers.*—Assist in the operations as directed by the chief of section.

■ 44. LUBRICATION.—*a.* To facilitate identification, all oil holes and grease fittings should be marked with bright red enamel.

b. Lubrication instructions for the gun and carriage are covered in figure 6.

c. The following lubricants are issued by the Ordnance Department for use on this matériel:

(1) *Engine (crankcase) oil, SAE 10* (Navy contract symbol 1042).—A pure petroleum oil used for general purpose lubrication when the temperature is below 32° F. When Navy contract oil is unobtainable, use premium or regular brand of first quality SAE 10 motor oil sold by reputable companies.



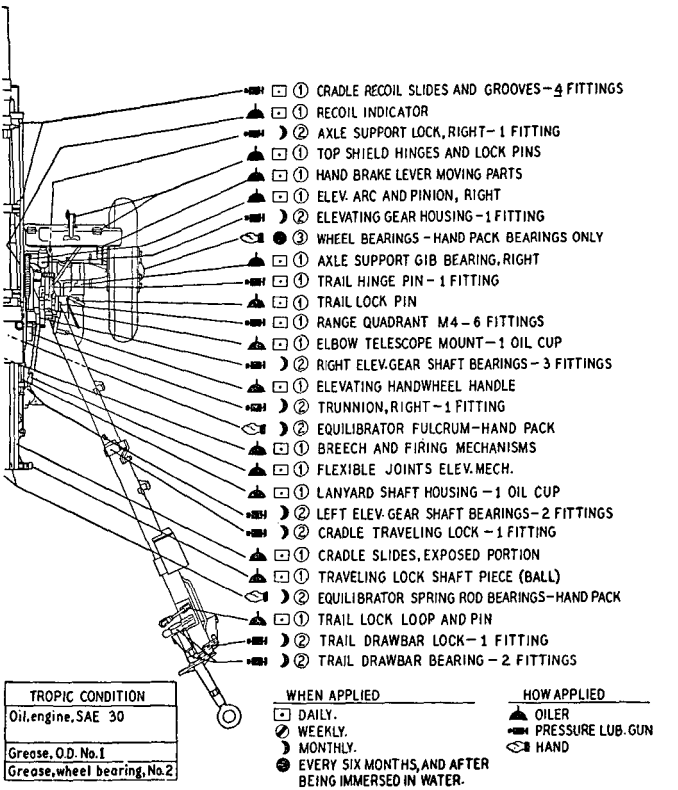
LUBRICANTS REQUIRED

	TEMPERATE CONDITION	ARCTIC CONDITION
①	Oil, engine, SAE 10 for below 32°F Oil, engine, SAE 30 for above 32°F	Oil, lubricating, for aircraft instruments and machine guns
②	Grease, O.D. No. 0	Grease, O.D. No. 00
③	Grease, wheel bearing, No. 2	Grease, wheel bearing, No. 2

FIGURE 6.—Lubrication chart,

(2) *Engine (crankcase) oil, SAE 30* (Navy contract symbol 1065 or 3065).—An oil used for general lubricating purposes as in (1) above, when the temperature is above 32° F.

(3) *Grease, O. D. No. 0* (Treasury contract, TPS, class 14).—An automotive type of mineral grease. It is used in the grease fittings of the howitzer in both summer and winter. At least every 6 months all old grease is removed; the gear boxes and housing are cleaned with dry-cleaning solvent, wiped dry, and packed with new grease.



105-mm howitzer, M2.

(4) *Grease, wheel bearing, No. 2* (Treasury contract, TPS, class 14).—A special grease containing soap. It has a stringy consistency. It is used for the high-speed roller bearings in the wheel hubs. It does not run when hot, but is soluble in water; consequently, repacking is required after continued immersion in water. Wheel hubs are not packed, as this may permit grease to reach the brake mechanism.

■ 45. PROTECTION AGAINST CHEMICALS.—*a.* Whenever chemical attacks are anticipated, all bright parts should be covered

with oil. After a gas attack, the oil is wiped off and fresh oil applied. If mustard or other persistent gas is used, absorbent objects may be deeply contaminated, and even hard surfaces may be dangerous for from 6 to 8 days, if the chemical is not neutralized. Bleaching powder or chloride of lime and a noncorrosive decontaminating agent (a solution of either a light tan or white powdery material in acetylene tetrachloride) are standard. The noncorrosive agent will be used for the decontamination of weapons when corrosion or other serious damage might result from the use of chloride of lime.

b. The noncorrosive decontaminating agent is sprayed on with the hand-operated decontaminating apparatus. The contaminated surfaces should be given a number of light applications of the spray at intervals of 15 to 30 minutes until the required amount of solution has been applied (see FM 21–40). After all the solution has evaporated from the treated surfaces, the matériel should be scrubbed, preferably with soapy water, rinsed with clear water, and thoroughly dried. When appropriate, metal surfaces should then be oiled or greased to prevent corrosion.

c. Chloride of lime, if used, may be sprinkled on the matériel, painted on as a whitewash, or sprayed on with the hand-operated decontaminating apparatus. The application should not be left on for more than an hour at most, after which the lime is washed off and the matériel rinsed thoroughly with water.

d. All cleaning rags and sticks used in decontamination must be destroyed or otherwise disposed of to prevent danger from subsequent handling. If destroyed by burning, care must be taken to prevent contamination by dangerous vapors produced. If possible, the articles should be buried. In all cleaning operations, the gas mask and special gasproof gloves must be worn.

■ 46. RECOIL MECHANISM.—*a. General.*—Battery maintenance of the recoil mechanism is limited to exterior cleaning and lubricating, draining and filling with recoil oil, removing the recoil cylinder rear head, and disconnecting the piston rod from the cradle. Whenever the barrel is removed, the recoil cylinder rear head should be removed in order to clean the rear interior of the recoil cylinder and to inspect for excess oil leakage. At this time the rear head should be thor-

oughly cleaned and the relief valve should be lubricated and checked for correct functioning. Only the heavy low-pour-point recoil oil as issued by the Ordnance Department may be used in the recoil mechanism. A full reserve of oil for the recoil system amounts to approximately 1½ fills of the screw filler. In using the screw filler, care must be exercised to prevent crossing the threads or breaking off the end of the filler. The screw handle must be turned with both hands. The amount of oil reserve in the system is shown by the position of the oil index with reference to the front face of the recuperator cylinder front head, as follows:

(1) *No reserve.*—The indicator is well into the recess. The piece must not be fired in this condition.

(2) *Full reserve.*—The end of the indicator is even with the front face of the recuperator cylinder front head. The oil index does not of itself show when there is an excess of oil reserve, as the addition of excess oil does not move the index out beyond the front face of the recuperator cylinder front head. The piece must not be fired with an excess reserve (see *b* below).

b. Operations prior to firing.—(1) Before firing, the reserve oil should be extracted until an insufficient reserve is indicated; then a full reserve should be established by inserting oil until the index is flush with the front face of the recuperator cylinder front head.

(2) The rear end of the recoil cylinder, the filling-and-drain-plug hole, and the oil index recess should be examined for oil leakage. The presence of a few drops of oil at any of these places is to be expected, but if there is an undue leakage the piece must not be fired, and the condition should be reported to ordnance personnel.

c. Operations during firing.—(1) During firing, the recoil mechanism should be maintained at full reserve and the slides kept clean and properly lubricated.

(2) The chief of section should constantly verify the complete return of the piece to battery. Firing may be continued as long as the piece returns to battery sufficiently for the firing mechanism to actuate the trigger shaft.

(3) The chief of section should constantly observe the behavior of the recoil mechanism in firing, and take such action in the case of malfunctioning as is indicated below:

Malfunction	Cause	Correction
Oil index projects less than the required distance.	(1) Loss of reserve oil. (2) Loss of gas pressure either through the recuperator cylinder rear head or past the floating piston.	(1) Drain the remainder of the oil reserve and refill to normal. (2) Gas escaping by the floating piston is indicated by an emulsified condition of the reserve oil drained off. If in reestablishing the oil reserve, the oil index does not move out and the oil screw filler works easily, the gas pressure has been lost. Substantiate this by an attempt to drain the mechanism. Oil will not spurt out unless some pressure is present. Report the malfunctioning to ordnance personnel for repair.
Oil index remains stationary when the reserve is pumped in against evident pressure.	The packing is too tight, or the index is broken, or the index is locked by some foreign substance.	Withdraw all reserve oil, then insert approximately 1½ the capacity of the oil screw filler. Tap the oil index lightly as oil is being added. If it still fails to function, report the malfunctioning to ordnance personnel for repair. (*In an emergency*, drain all reserve oil and insert 1½ fills of the screw filler; the piece then may be fired until the howitzer returns to battery with a shock when reserve oil should be extracted, or the howitzer fails to return to battery when additional oil should be inserted.)
Failure of howitzer to return to battery.	(1) Insufficient oil reserve. (2) Dirt or obstruction on the slides. (3) Relief valve in recoil cylinder rear head not functioning (4) Low nitrogen pressure, excessive internal friction; damaged slides, piston rod or piston.	(1) Withdraw the reserve oil and establish a new full reserve. (2) Clean and lubricate the slides. (3) Remove recoil cylinder rear head and clean. If malfunction continues, report the malfunctioning to ordnance personnel for repair. (4) Report malfunction to ordnance personnel for repair.

Malfunction	Cause	Correction
Return of howitzer to battery with a shock.	Too much oil reserve.	Withdraw reserve oil until index is halfway in and, when mechanism has cooled, refill to a full reserve.

■ 47. BARREL ASSEMBLY AND SLIDES.—*a. Care of bore.*—Whenever the rate of firing permits, the bore should be swabbed with clean water and a sponge; such swabbing should be done at least once every hour during firing. During or just prior to firing, it is unnecessary and undesirable to lubricate the bore. Drying subsequent to swabbing should be insisted upon. As soon as possible after firing, the bore is washed with a solution of ½ pound of soda ash (or 1 pound of sal soda) per gallon of hot water. Cleaning of the bore is accomplished by means of a swab of burlap around the metal end of the rammer staff, or by means of the bore cleaning brush. No attempt should be made to remove copper fouling. When all powder fouling has been removed, the bore is swabbed with clear water. Finally, it is dried with clean burlap or cloths and then coated with engine oil, either SAE 10 or SAE 30 depending upon the temperature. The cleaning process may have to be repeated on successive days if there is evidence of sweating. If the piece is not to be kept in constant service, the bore should be slushed with rust-preventive compound instead of oil. The chief purposes of swabbing the bore during the firing period are to flush out the primer salts and residue and to lower the temperature of the barrel. The purpose of cleaning after firing is to remove all traces of the residue and primer salts that cause corrosion. A clean bore is indicated by a uniform grey appearance; no attempts should be made to obtain a bright, polished appearance since such attempts result in damage to the bore.

b. Care of slides.—The bronze slides should be examined by retracting the howitzer until the rear of the breech is opposite the rear of the cradle. Burs or rough spots are removed with a fine file. The slides are cleaned with dry-cleaning solvent, wiped dry, and coated with a light film of engine oil. After the gun is secured in battery, engine oil is applied to the slides through the eight oil fittings. Period-

ically, or at least every 2 weeks when in constant service, the howitzer and sleigh should be removed from the cradle in order to permit cleaning the entire length of the slides and the interior of the cradle.

c. To retract howitzer.—The howitzer is retracted on its slides as follows:

(1) Set the hand brakes.

(2) Place the howitzer at approximately zero elevation and lash the elevating handwheel to the right shield brace.

(3) Remove the cotter pin and piston rod outer nut.

(4) Push the howitzer and sleigh to the rear, being careful that the howitzer and sleigh are not pushed so far to the rear that the breech ring bearing strips lose contact with the rear of the cradle.

d. To remove howitzer and sleigh.—To prevent damaging the recoil mechanism, first the howitzer is removed and then the sleigh is removed. The procedure is as follows:

(1) Provide at least three heavy timbers and two rope slings to support the howitzer in a horizontal position when it is being removed.

(2) Set the hand brakes.

(3) Remove the breechblock.

(4) Place the howitzer at approximately zero elevation and lash the elevating handwheel to the right shield brace.

(5) Remove the locking screw in the recoil mechanism bracket locking ring (barrel locking ring) and remove the ring.

(6) Start the howitzer to the rear by striking the muzzle with one of the lifting timbers or by means of a pinch bar inserted between the front of the breech ring and the rear edge of the cradle trunnion bracket.

(7) Push the howitzer about 12 inches to the rear.

(8) Using timbers and a rope sling, support the breech and muzzle ends of the howitzer to avoid cramping, and carry the howitzer to the rear. The third timber and a rope sling are used to support the middle of the howitzer as soon as the front end passes within the sleigh. Place the howitzer on wooden blocks or a suitable rest to prevent damage to the finished surfaces and the bronze bearing strips in the bottom face of the breech ring.

(9) Remove the cotter pin and piston rod outer nut.

(10) Four cannoneers working in pairs on opposite sides of the carriage push the sleigh to the rear until it is free from the cradle, then lift it off and place it on wooden blocks.

e. To replace howitzer and sleigh.—The howitzer and sleigh are replaced by reversing the procedure of *c* or *d* above. The piston rod outer nut should be fully tightened and then backed off to the nearest castellation in order to permit side play without noticeable end play; it must not be drawn so tight that the inner nut is tight against the cradle. The chief of section must verify before traveling and before firing that the piston rod outer nut and its cotter pin are in place.

■ 48. BREECH AND FIRING MECHANISMS.—*a. General.*—Since the breech and firing mechanisms consist entirely of unpainted and unprotected steel surfaces, the mechanisms are subject to corrosion caused by powder fouling, rain, dirt, and mud. It is of particular importance that the moving elements be kept well cleaned and lubricated. This can be accomplished in only one way; that is, by a complete disassembly of all moving parts. The solution of water and soda ash (or sal soda) is used to remove the larger portion of the fouling. After the parts are rinsed with clear water and dried, any gummy residue remaining on them is removed with dry-cleaning solvent. The mechanism is lubricated while disassembled. It is important that the mechanism is thoroughly cleaned and dried before being lubricated, that the proper lubricant is selected, and that it is used in quantities sufficient only to reduce friction. In case of doubt as to the viscosity of oil to be used, especially when the piece is to be fired, the lighter weight of oil should be selected. Constant checking is necessary to insure that cracked parts are replaced, and that burred parts are replaced or burs removed. Hence, whenever the mechanism is disassembled, each part should be carefully inspected.

b. Disassembly of breech mechanism and firing lock.—To disassemble the breech mechanism—

(1) Raise the detent handle and remove the trigger shaft.

(2) Open the breech to the point where the assembling line on the top of the operating lever is parallel with the side of the breech ring and lift out the operating-lever pivot.

(3) Slide the breechblock to the right, removing the operating lever as soon as the crosshead clears the breech ring.

(4) Push the breechblock to the left to clear the extractor and remove the extractor from the breech ring.

(5) Remove the breechblock by pushing through to the right.

(6) Lay the breechblock on its lower face and remove the detent spring retaining screw, spring, detent, and handle.

(7) Rotate the firing case 60° in either direction and pull it out of the breechblock.

(8) Pry the trigger fork out of the firing case with a screw driver, first through the trigger shaft hole, then from the outside of the case.

(9) Insert the trigger shaft to engage the yoke ends of the sear. Press the front end of the sear out of engagement with the firing-pin holder, insert a screw driver through the bottom hole and in rear of the firing-pin holder, and pry the assembled sleeve and holder forward until they can be grasped and pulled from the case.

(10) Remove the trigger shaft and shake out the sear and sear spring.

(11) Hold the front end of the firing-pin holder in one hand and place the lower rear end of the sleeve against the edge of a bench or some convenient part of the carriage. Push the firing-pin holder down to unhook it from the sleeve. Allow the holder to recede out of the sleeve, freeing the spring.

(12) Remove the cotter pin from the firing-pin holder, unscrew the firing-pin bushing, and remove the firing pin from the bushing.

(13) Unscrew the cross-head screw and remove the cross head.

c. Assembly of breech and firing mechanisms.—The breech and firing mechanisms are assembled in the reverse order of the disassembly described in *b* above. However, the following aids and precautions should be observed.

(1) The ends of the cotter pin in the firing-pin holder must be spread so that they will not rub the firing case.

(2) The sear spring may be readily inserted into its seat by introducing the point of a screw driver between two coils to hold the spring.

(3) The sear should be pressed down when the firing-pin holder is inserted in the case. This is easily done by inserting a screw driver through the front top hole of the firing case.

(4) The part of the trigger fork marked "muzzle face" must be toward the front of the case when assembling.

(5) The trigger shaft may be inserted when the lines on the firing case and the breechblock marked "top" coincide.

d. The causes and corrections of malfunctioning of the breech and firing mechanisms are given in the following table:

Malfunction	Cause	Correction
Fails to fire; no percussion on primer.	(1) Broken firing spring; broken or deformed firing pin.	(1) Disassemble firing lock and replace broken or deformed part.
	(2) Breechblock not fully closed.	(2) Close breechblock.
	(3) Howitzer out of battery.	(3) Check recoil mechanism for proper reserve and howitzer slides for dirt or obstructions. If cause is not found, report malfunctioning to ordnance personnel for repair.
Fails to fire until primer is struck several times.	(1) Firing mechanism parts not working freely.	(1) Disassemble firing lock and examine for burs and roughened surfaces. Remove burs, and smooth roughened surface with crocus cloth or an oilstone. Wash parts with dry-cleaning solvent, dry and lubricate before reassembly.
	(2) Weak firing spring.	(2) Replace.
Fails to fire when proper percussion on primer is obtained (misfire).	Defective primer.	Make three attempts to fire the primer, then wait 2 minutes before opening breech and removing round. (See par. 38.)
Fails to extract empty case.	Broken extractor.	Gently ram out the case. Examine the edge of the chamber for deformations or burs which might cause difficult extraction. Replace extractor.

■ 49. EQUILIBRATOR.—*a. General.*—To clean and lubricate the equilibrator spring rod bearing and fulcrum bearing, the equilibrator assembly should be dismounted from the carriage once a month. After the equilibrator is removed, the bearings are washed in dry cleaning solvent, dried, and hand packed with grease, O. D. No. 0. Disassembly of the equi-

librator is prohibited. There are no means provided for adjusting the equilibrator.

b. To remove.—The equilibrator is removed as follows:

(1) Depress the piece to approximately zero elevation, insert a 3- by 3- by 12-inch wood block between the front spring seat and equilibrator fulcrum, and elevate the piece to remove the load from the springs.

(2) Remove the cotter pins, and force out the headless pins from the equilibrator fulcrum. Depress the piece, lowering the front end of the equilibrator to the ground. Protect it from the dirt.

(3) Drive out the straight pin from the traveling lock (ball) piece on the right side of the cradle.

(4) Unscrew the ball piece.

(5) Gently push the traveling lock shaft to the left, holding the equilibrator to prevent its falling, and remove the equilibrator assembly.

c. To mount.—Reverse the procedure of *b* above, noting that the dust shields on either side of the equilibrator fulcrum bearing are in place.

■ 50. ELEVATING MECHANISM AND CRADLE TRUNNION BEARINGS.—Disassembly, cleaning, and inspection of the elevating mechanism and cradle trunnion bearings, and packing of the elevating mechanism gear housings will be done at the regular ordnance inspections.

■ 51. WHEELS AND WHEEL BEARINGS.—*a. General.*—(1) The care and maintenance of the wheel mechanism, including tires, is a function of the battery. Tire pressure should be maintained at 40 pounds. Tires should be removed at least once a year and the disk and rim cleaned and painted. Every 6 months, or oftener if necessary, the wheel hubs should be removed, the old grease flushed out, new grease pressed by hand into the space between the cleaned and dried rollers and race, and the wheel bearings adjusted. Best results are obtained if, after drying and before repacking, the roller bearing is dipped into engine oil. Improper adjustment of the roller bearings will cause the rollers to be pitted or chipped. In general, a bearing chipped at the larger end indicates that the adjustment was too tight; a bearing chipped at the smaller end indicates too loose an adjustment.

At all halts during marches, the chiefs of section or a designated cannoneer should feel the wheel hubs for overheating.

(2) Overheating may be an indication of a tight bearing, faulty lubrication, or a dragging brake. The cause must be determined and correction made as directed by the officer in charge.

b. Disassembly.—To disassemble the wheel hub from the spindle—

(1) Remove the hub cap.

(2) Remove the cotter pin, castellated nut, and washer from the spindle.

(3) Pull the hub from the spindle, being careful to prevent the outer roller bearing from falling to the ground.

c. Assembly and adjustment.—To assemble the wheel hub on the spindle and to adjust the wheel bearings—

(1) Clean and dry the bearings, dip the bearings in engine oil, and fully pack with wheel-bearing grease. See that the inner bearing is properly in place; the oil retainer must not bear against the roller bearing. The hub cavity must not be packed.

(2) Slide the wheel hub over the spindle, guiding the cup of the inner roller bearing over the cone and rollers and the brake drum over the brake shoe.

(3) Slide the outer cone and roller on the spindle, and press it firmly into its seat in the hub.

(4) Install the washer and nut, and adjust the bearing. To make this adjustment, the wheel should be rotated as the adjusting nut is being tightened. It is best to rotate the wheel in both directions, drawing up the nut until all the bearing parts are firmly seated. At this point a drag or resistance to rotation will be noted on the wheel. The nut should now be backed off from one-sixth to one-quarter of a turn. Now the wheel should rotate freely but without any perceptible shake.

(5) Test the bearing adjustment by placing a short bar between the tire and the ground, at the same time holding one finger on the cage of the outer bearing. When, in working the bar up and down, a barely perceptible movement is felt and the wheel rotates freely when given a slight spin, the adjustment is correct. Insert the cotter pin and attach the hub cap.

■ 52. BRAKE MECHANISM.—*a. General.*—This weapon is equipped with hand brakes for use during firing or while the piece is being moved by hand, and with commercial Warner electric brakes for use during travel. Periodic testing of both the hand and electric brake mechanisms is necessary. No adjustment of the brake shoes is provided.

b. Hand brakes.—If the hand brake mechanism fails to hold the weapon, the brake shoes may be replaced or the brake lever may be removed from its splined shaft and rotated enough to enable the brakes to hold. The hand-brake levers should not be rotated so far that they will affect the operation of the electric brakes.

c. Electric brakes.—When testing the brake mechanism the procedures and precautions of TM 9–325 should be observed. The causes and corrections of malfunctioning of the electric brakes are given in the following table:

Malfunction	Cause	Correction
No brakes	(1) Broken wire in circuit.	(1) Check wiring and repair broken wires.
	(2) Controller defective. (Test controller by connecting both wires to one terminal and checking brake operation.)	(2) Replace controller.
	(3) Poor connection	(3) Check, clean, and tighten all connections at brake, controller load control, and socket.
	(4) Broken wire or magnet.	(4) If broken wire is on outside of magnet, repair if possible. If no current flows through magnet, replace with new magnet.
	(5) Poor ground connection in circuit.	(5) Clean and tighten connections.
	(6) Defective plug or socket.	(6) Check plug and socket for loose connections, dirty or corroded blades, or a broken socket. Repair or replace with new socket.
Very weak brakes	(1) Worn-out brake lining.	(1) Replace brake band assembly.
	(2) Glazed magnet facing.	(2) Roughen with emery cloth.

Malfunction	Cause	Correction
	(3) Stop lights connected in brake circuit. (Changes the graduation of the current as it passes through the controller, resulting in weak or grabbing brakes.)	(3) Remove stop lights from brake circuit.
	(4) Insufficient current.	(4) Insufficient current may be due to poor connections at the brake, controller and load control ground, or the plug and socket. Clean and tighten all connections; check plug and socket for corroded or dirty blades.
	(5) Poor ground connection at the brakes.	(5) Clean and tighten contacts at the brake and frame.
	(6) Controller burned out.	(6) Replace with new controller.
	(7) Contactor arm in the controller is pitted.	(7) Smooth out contactor arm with fine emery cloth.
	(8) Broken magnet spring.	(8) Replace with new spring.
	(9) Worn wheel bearings.	(9) Replace bearings.

■ 53. SIGHTING AND FIRE-CONTROL EQUIPMENT.—*a. General.*— Especial care is required to insure the positive and accurate functioning of the sighting and fire-control mechanisms. Care must be exercised to prevent denting the soft metal surfaces or scratching the lenses. The steel surfaces should be kept covered with a light film of high-grade lubricant to prevent corrosion. Dirt should be removed from optical surfaces by brushing lightly with a camel's hair brush. Oil or grease should be removed from glass by applying alcohol or, if alcohol is not available, by breathing on the glass and then wiping lightly with lens paper or a clean, soft cloth. Battery personnel are forbidden to disassemble any part of the gunner's quadrant, panoramic or elbow telescopes, telescope mounts, or range quadrant, but are permitted to perform certain adjustments. The procedures of *c* to *f* below may be used to insure accuracy of the sighting and laying mechanisms. In general, the sighting system is correct—

(1) In *direction,* if the deflection scales read zero when

the line of sighting is in a plane parallel to the vertical plane passing through the axis of the bore.

(2) In *elevation*—

(*a*) If, with the elevation scales of the panoramic telescope set at zero and with the elevation indexes of the mount in coincidence, the line of sighting through the zero range line of the telescope is parallel to the axis of the bore.

(*b*) If the algebraic sum of the "site" and "elevation" setting indicates the same angle above the horizontal that is measured with an accurate gunner's quadrant on the tube.

(3) If there is no excessive lost motion between the sights and the tube.

b. Testing equipment.—Equipment used in testing sights consists of bore sights and a gunner's quadrant. Tools needed for adjustments are a screw driver and a teat-wrench. The target for bore sighting may be a terrain object more than 1,000 yards away, or a test target. When the test target is used, the displacement of the axis of sighting from the axis of the bore must be correctly shown. For this howitzer the displacement of the panoramic telescope is 15.23 inches to the left of and 10.61 inches above the axis of the bore, and the displacement of the elbow telescope is 13.375 inches to the right of and 8.375 inches above the axis of the bore. Aiming posts with wooden blocks or markers attached make a suitable test target. Tests can be made without the bore sights by sighting through the firing lock recess in the breechblock or through a brass cartridge case with the primer removed, using improvised cross hairs at the muzzle.

c. Gunner's quadrant.—(1) *End-for-end test.*—(*a*) Set both the graduated arc and index arm (sliding level) scales at zero, and tighten the clamp screw.

(*b*) Place the quadrant on the leveling plates of the howitzer and center the bubble, using either elevating handwheel of the piece.

(*c*) Reverse the quadrant on the leveling plates. The bubble should recenter itself. If it does not, change the setings until the bubble is centered and take the reading. In the case of a minus correction it will be necessary to set the graduated arc scale one notch below zero, and move the sliding level initially to the opposite end of the index arm. The correction (the setting to be used in getting a true horizontal) is one-half of the displacement measured, in the same sign.

If the necessary correction exceeds 0.3 mil, the quadrant should be adjusted by ordnance personnel at the earliest opportunity.

(2) *Index arm test.*—Set a reading of any multiple of 10 on the quadrant and place the sliding level at zero. Level the bubble by means of either elevating handwheel of the piece. Move the index arm one notch down, and slide the level vial to the opposite end of the scale. The bubble should remain centered.

(3) *Comparison test.*—Successively place the five quadrants of the battery on the leveling plates of a piece which is laid at any selected elevation. Repeat the same process for several other elevations and list the reading of each quadrant at each elevation. Determine a mean correction for each quadrant and apply this as a correction constant. If any quadrant exceeds an error of 0.3 mil it should be adjusted by ordnance personnel at the earliest opportunity.

d. Rapid daily test.—The on-carriage fire-control equipment is rapidly checked for correct adjustment in the following manner:

(1) The chief of section sets the gunner's quadrant at zero, places it on the leveling plates, and No. 1 levels the piece.

(2) No. 1 sets the angle-of-site scales at 300 and centers the cross-level and angle-of-site bubbles. The elevation scales should read zero. (The range drum will not read exactly zero due to the allowance for jump.)

(3) The gunner centers the longitudinal and cross-level bubbles of the telescope mount. The elevation indexes should be in coincidence.

(4) Nos. 1 and 2 install the bore sights and, if necessary, set up the testing target. The gunner lays the piece by bore sighting on the testing target or distant terrain object.

(5) The gunner lays the center vertical cross hair and the zero horizontal cross hair of the telescope reticule on the proper portion of the test target. If the telescope is in adjustment the azimuth and elevation scales and their respective micrometer scales will indicate zero deflection and elevation.

(6) No. 1, by observation, restores the range lines in the reticule of the elbow telescope to the horizontal with the erecting knob. The N (normal) cross hair of the reticule should be on the appropriate line of the test target.

(7) If the foregoing tests indicate that some portion of the mechanism is out of adjustment, it should be adjusted by following the procedure outlined in *c* above and *f* and *g* below, or a correction should be determined, written on some convenient location such as the shield, and used until there is an opportunity to adjust the faulty mechanism.

e. Verification and adjustment of the telescope mount and the panoramic telescope.—Periodically, and whenever the mechanism is found to be out of adjustment, a detailed test and adjustment should be made. For this purpose it is desirable to have the howitzer on an approximately level platform or the howitzer trunnions level. It is assumed that all lost motion has been eliminated and that cross-level bubbles are in adjustment. (For details see TM 9–325.) Tests and adjustments are performed in sequence as follows:

(1) *Elevation indexes of telescope mount.*—Lay the howitzer at zero elevation with the gunner's quadrant and center the cross-level and longitudinal-level bubbles. The elevation indexes should coincide; if they do not, loosen the two screws in the adjustable index and slide it into coincidence with the fixed index. Tighten the screws and recheck.

(2) *Deflection and range scales of the panoramic telescope.*—Bore sight on the test target or a distant terrain object. Insure that the elevation indexes of the telescope mount are in coincidence. Using the appropriate knobs of the telescope, place the center vertical cross hair and zero horizontal cross hair of the telescope reticule on the proper portion of the test target. If the azimuth and elevation scales and their respective micrometer scales do not indicate zero deflection and elevation, adjust in the following manner:

(*a*) *Deflection adjustment.*—Turn the azimuth worm knob of the telescope until the center vertical cross hair is on the appropriate line of the test target. Loosen the screw in the center of the azimuth micrometer index and, while holding the azimuth worm knob, slip the index until it corresponds with the deflection index. Tighten the screw and recheck. This adjustment must not be made by moving the headless adjusting screws in the telescope socket. If necessary, the main azimuth scale should also be adjusted to zero.

(*b*) *Elevation adjustment.*—Turn the elevating knob of the telescope until the zero horizontal cross hair of the reticule corresponds with the appropriate mark of the testing

target. Loosen the screws in the end of the knob and, holding the knob, slip the elevation micrometer until the zero graduation lines up with its index; then tighten the screws and recheck the setting.

f. Verification and adjustment of range quadrant.—(1) Move the range drum assembly indexes into coincidence. The elevation micrometer scale and the elevation scale should read zero. The range drum will indicate a reading slightly greater than zero if properly assembled.

(2) With the range drum properly assembled, if the elevation micrometer scale does not read zero, it is adjusted in the following manner:

(*a*) Loosen the three screws in the micrometer knob.

(*b*) Without moving the knob, slide the zero of the micrometer scale into coincidence with the index.

(*c*) Tighten and recheck.

(3) With the elevation micrometer scale in adjustment, if the elevation scale does not indicate zero, it is adjusted in the following manner:

(*a*) Loosen the two screws in the index. Move the index opposite the zero graduation.

(*b*) Move the index into coincidence with the zero graduation.

(*c*) Tighten the screws and recheck.

(4) With the elevation micrometer scale and the elevation scale in adjustment and set at zero, the trunnions and the axis of the bore are accurately leveled, the angle of site is set at 300, and the cross-level bubble is centered. If the longitudinal-level bubble is not centered, the range quadrant is adjusted in the following manner:

(*a*) Center the longitudinal bubble by means of the angle-of-site knob.

(*b*) While holding the angle-of-site knob, loosen the clamping screw in the meter of the knob and slip the angle-of-site micrometer to indicate zero. Tighten the clamping screw.

(*c*) If necessary, loosen the two screws which secure the angle-of-site scale and shift the scale so that the "3" graduation registers at the index line. Tighten the screws to secure the scale in this position.

(*d*) Recheck. Further adjustment, if required, is to be performed only by authorized ordnance personnel.

g. Verification and adjustment of the elbow telescope and its mount.—With the axis of the trunnions leveled, bore sight on the test target. By observation, correct the reticule to the horizontal by means of the erecting knob. If the N cross hair is not on its line of the test target, put it on in the following manner:

(1) Loosen the worm clamping bolt.

(2) With a screw driver, move the elevating adjusting worm to bring the N cross hair in coincidence with the proper line of the target.

(3) Tighten the worm clamping bolt.

(4) Recheck.